(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 August 2020 (20.08.2020)

(10) International Publication Number
WO 2020/163983 A1

(51) International Patent Classification:
H04W 64/00 (2009.01) *G01S 5/02* (2010.01)

(21) International Application Number:
PCT/CN2019/074795

(22) International Filing Date:
11 February 2019 (11.02.2019)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicants *(for CN only)*: **NOKIA SHANGHAI BELL CO., LTD.** [CN/CN]; No. 388, Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN). **NOKIA SOLUTIONS AND NETWORKS OY** [FI/FI]; Karaportti 3, FI-02610 Espoo (FI).

(71) Applicant *(for all designated States except CN)*: **NOKIA TECHNOLOGIES OY** [FI/FI]; Karaportti 3, FI-02610 Espoo (FI).

(72) Inventors: **LIU, Jianguo**; No. 388 Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN). **TAO, Tao**; No. 388 Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN). **MENG, Yan**; No. 388 Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN). **SHEN, Gang**; No. 388 Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN).

(74) Agent: **KING & WOOD MALLESONS**; 20th Floor, East Tower, World Financial Centre, No. 1 Dongsanhuan Zhonglu, Chaoyang District, Beijing 100020 (CN).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

(54) Title: ENHANCED POSITIONING MECHANISM BASED ON OTDOA

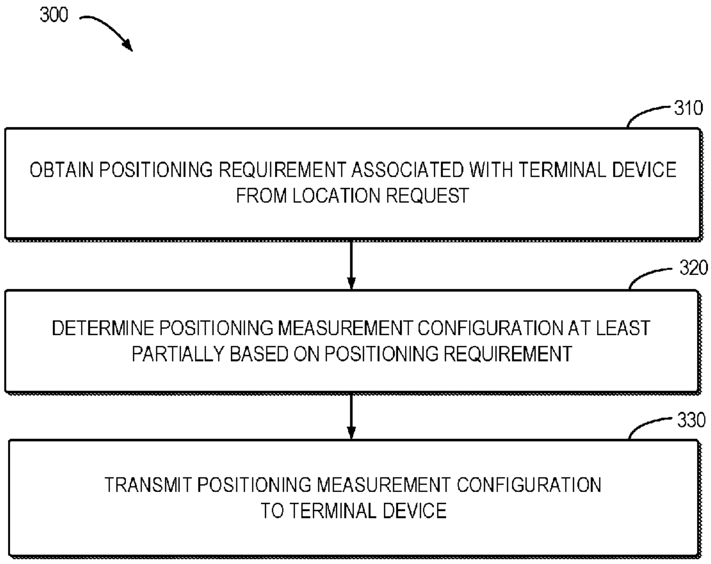

FIG. 3

(57) **Abstract:** Embodiments of the present disclosure relate to the enhanced positioning mechanism based on Observed Time Difference Of Arrival (OTDOA). A method of object management comprises in response to receiving, at a location server, a location request for positioning a terminal device from a location client, obtaining a positioning requirement associated with the terminal device from the location request; determining a positioning measurement configuration at least partially based on the positioning requirement, the positioning measurement configuration indicating a set of target cells for positioning the terminal device; and transmitting the positioning measurement configuration to the terminal device, to enable the terminal device to perform a positioning measurement based on the positioning measurement configuration. In this way, as the number of required cells for Reference Signal Time Difference (RSTD) measurement would greatly reduce, this solution can provide desired positioning performance with reduced power consumption for the target UE.

WO 2020/163983 A1

[Continued on next page]

HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

ENHANCED POSITIONING MECHANISM BASED ON OTDOA

FIELD

[0001] Embodiments of the present disclosure generally relate to the field of telecommunication and in particular, to an enhanced positioning mechanism based on Observed Time Difference Of Arrival (OTDOA).

BACKGROUND

[0002] Recently, the study item on NR Positioning was approved for Rel-16 NR. In LTE and Rel-15 NR, there main positioning techniques including Observed Time Difference Of Arrival (OTDOA), Enhanced Cell-ID (E-CID) and Uplink Time Difference of Arrival (UTDOA) have been implemented. In Rel-16 NR, the further enhancements on OTDOA technology will be expected.

[0003] The OTDOA is a downlink positioning technology in which the target UE measures TOA (Time of Arrival) of the Positioning Reference Signals (PRS) transmitted from the reference cell and neighbour cells, and reports the reference signal time differences (RSTDs), which are used to determine the location of the target UE. To support OTDOA, the higher layer signalling, i.e. the transfer of OTDOA assistance data and transfer of RSTD measurement, between the UE and location server, for example, an Evolved Serving Mobile Location Centre (E-SMLC) or a Service Positioning Protocol (SLP). Herein, the *ProvideAssistanceData* message body in a LPP message is used by the location server to provide assistance data to the UE. The *IE OTDOA-ReferenceCellInfo* and the *IE OTDOA-NeighbourCellInfoList* are used by the location server to provide assistance data information of the reference cell and the neighbouring cells for OTDOA assistance data, respectively. For the target UE, it would be critical for providing not only the high accuracy positioning but also low measurement complexity for preserving battery lifetime.

SUMMARY

[0004] In general, example embodiments of the present disclosure provide a solution for an enhanced positioning mechanism based on OTDOA.

[0005] In a first aspect, there is provided a method for an enhanced positioning mechanism based on OTDOA. The method comprises in response to receiving, at a location server, a location request for positioning a terminal device from a location client, obtaining a positioning requirement associated with the terminal device from the location request; determining a positioning measurement configuration at least partially based on the positioning requirement, the positioning measurement configuration indicating a set of target cells for positioning the terminal device; and transmitting the positioning measurement configuration to the terminal device, to enable the terminal device to perform a positioning measurement based on the positioning measurement configuration.

[0006] In a second aspect, there is provided a method for an enhanced positioning mechanism based on OTDOA. The method comprises receiving, at a terminal device, the positioning measurement configuration from a location server, the positioning measurement configuration being determined at least partially based on a positioning requirement associated with the terminal device and indicating a set of target cells for positioning the terminal device, the positioning requirement is obtained from a location request transmitted from a location client to the location server; performing a positioning measurement based on the positioning measurement configuration; and determining a positioning measurement report based on a result of the positioning measurement.

[0007] In a third aspect, there is provided a device for an enhanced positioning mechanism based on OTDOA. The device comprises at least one processor; and at least one memory including computer program codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the device at least to receive, at a location server, a location request for positioning a terminal device from a location client, obtaining a positioning requirement associated with the terminal device from the location request; determine a positioning measurement configuration at least partially based on the positioning requirement, the positioning measurement configuration indicating a set of target cells for positioning the terminal device; and transmit the positioning measurement configuration to the terminal device, to enable the terminal device to perform a positioning measurement based on the positioning measurement configuration.

[0008] In a fourth aspect, there is provided a device for an enhanced positioning mechanism based on OTDOA. The device comprises at least one processor; and at least one memory including computer program codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the device at least to receive, at a terminal device, the positioning measurement configuration from a location server, the positioning measurement configuration being determined at least partially based on a positioning requirement associated with the terminal device and indicating a set of target cells for positioning the terminal device, the positioning requirement is obtained from a location request transmitted from a location client to the location server; perform a positioning measurement based on the positioning measurement configuration; and determine a positioning measurement report based on a result of the positioning measurement.

[0009] In a fifth aspect, there is provided an apparatus comprising means to perform the steps of the method according to the first aspect. The apparatus comprises means for in response to receiving, at a location server, a location request for positioning a terminal device from a location client, means for obtaining a positioning requirement associated with the terminal device from the location request; determining a positioning measurement configuration at least partially based on the positioning requirement, the positioning measurement configuration indicating a set of target cells for positioning the terminal device; and means for transmitting the positioning measurement configuration to the terminal device, to enable the terminal device to perform a positioning measurement based on the positioning measurement configuration.

[0010] In a sixth aspect, there is provided an apparatus comprising means to perform the steps of the method according to the second aspect. The apparatus comprises means for receiving, at a terminal device, the positioning measurement configuration from a location server, the positioning measurement configuration being determined at least partially based on a positioning requirement associated with the terminal device and indicating a set of target cells for positioning the terminal device, the positioning requirement is obtained from a location request transmitted from a location client to the location server; means for performing a positioning measurement based on the positioning measurement configuration; and means for determining a positioning measurement report based on a result of the positioning measurement.

[0011] In a seventh aspect, there is provided a computer readable medium having a computer program stored thereon which, when executed by at least one processor of a device, causes the device to carry out the method according to the first aspect.

[0012] In an eighth aspect, there is provided a computer readable medium having a computer program stored thereon which, when executed by at least one processor of a device, causes the device to carry out the method according to the second aspect.

[0013] It is to be understood that the summary section is not intended to identify key or essential features of embodiments of the present disclosure, nor is it intended to be used to limit the scope of the present disclosure. Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Some example embodiments will now be described with reference to the accompanying drawings, where:

[0015] FIG. 1 shows an example communication environment 100 in which example embodiments of the present disclosure can be implemented;

[0016] FIG. 2 shows a diagram of an example process 200 of the discontinuous reception for the terminal device according to some example embodiments of the present disclosure;

[0017] FIG. 3 shows a flowchart of an example method 300 of the discontinuous reception for the terminal device according to some example embodiments of the present disclosure;

[0018] FIG. 4 shows a flowchart of an example method 400 of the discontinuous reception for the terminal device according to some example embodiments of the present disclosure;

[0019] FIG. 5 is a simplified block diagram of a device that is suitable for implementing example embodiments of the present disclosure; and

[0020] Fig. 6 illustrates a block diagram of an example computer readable medium in accordance with some embodiments of the present disclosure.

[0021] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[0022] Principle of the present disclosure will now be described with reference to some example embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein can be implemented in various manners other than the ones described below.

[0023] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0024] As used herein, the term "communication network" refers to a network that follows any suitable communication standards or protocols such as long term evolution (LTE), LTE-Advanced (LTE-A) and 5G NR, and employs any suitable communication technologies, including, for example, Multiple-Input Multiple-Output (MIMO), OFDM, time division multiplexing (TDM), frequency division multiplexing (FDM), code division multiplexing (CDM), Bluetooth, ZigBee, machine type communication (MTC), eMBB, mMTC and uRLLC technologies. For the purpose of discussion, in some embodiments, the LTE network, the LTE-A network, the 5G NR network or any combination thereof is taken as an example of the communication network.

[0025] As used herein, the term "network device" refers to any suitable device at a network side of a communication network. The network device may include any suitable device in an access network of the communication network, for example, including a base station (BS), a relay, an access point (AP), a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a 5G or next generation NodeB (gNB), a Remote Radio Module (RRU), a radio header (RH), a remote radio head (RRH), a low power node such as a femto, a pico, and the like. For the purpose of discussion, in some embodiments, the eNB is taken as an example of the network device.

[0026] The network device may also include any suitable device in a core network, for example, including multi-standard radio (MSR) radio equipment such as MSR BSs, network controllers such as radio network controllers (RNCs) or base station controllers (BSCs), Multi-cell/multicast Coordination Entities (MCEs), Mobile Switching Centers (MSCs) and MMEs, Operation and Management (O&M) nodes, Operation Support System (OSS) nodes, Self-Organization Network (SON) nodes, positioning nodes, such as Enhanced Serving Mobile Position Centers (E-SMLCs), and/or Mobile Data Terminals (MDTs).

[0027] As used herein, the term "terminal device" refers to a device capable of, configured for, arranged for, and/or operable for communications with a network device or a further terminal device in a communication network. The communications may involve transmitting and/or receiving wireless signals using electromagnetic signals, radio waves, infrared signals, and/or other types of signals suitable for conveying information over air. In some embodiments, the terminal device may be configured to transmit and/or receive information without direct human interaction. For example, the terminal device may transmit information to the network device on predetermined schedules, when triggered by an internal or external event, or in response to requests from the network side.

[0028] Examples of the terminal device include, but are not limited to, user equipment (UE) such as smart phones, wireless-enabled tablet computers, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), and/or wireless customer-premises equipment (CPE). For the purpose of discussion, in the following, some embodiments will be described with reference to UEs as examples of the terminal devices, and the terms "terminal device" and "user equipment" (UE) may be used interchangeably in the context of the present disclosure.

[0029] As used herein, the term "location server" may refer to a service function which provides the positioning of the target UE to a location client. The location server may communicate with the target UE to obtain the positioning measurement report from the target UE via a high layer signaling. The location service may also communicate with the network device to obtain information associated with the positioning of the target UE. The location server may be a component independent of the network device. As an option, the location server may be any function module or function entity embedded in the network device.

[0030] Corresponding to the term "location server", the term "location client", as used herein, may refer to an application or entity which requests the location of the target UE. The location client may transmit a location request to the location service and receives the positioning of the target UE from the location server. Also, the location client may be considered as the target UE itself.

[0031] As used herein, the term "cell" refers to an area covered by radio signals transmitted by a network device. The terminal device within the cell may be served by the network device and access the communication network via the network device.

[0032] As used herein, the term "circuitry" may refer to one or more or all of the following:

(a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and

(b) combinations of hardware circuits and software, such as (as applicable): (i) a combination of analog and/or digital hardware circuit(s) with software/firmware and (ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and

(c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation.

[0033] This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit or processor integrated circuit for a mobile device or a similar integrated circuit in server, a cellular network device, or other computing or network device.

[0034] As used herein, the singular forms “a”, “an”, and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. The term “includes” and its variants are to be read as open terms that mean “includes, but is not limited to”. The term “based on” is to be read as “based at least in part on”. The term “one embodiment” and “an embodiment” are to be read as “at least one embodiment”. The term “another embodiment” is to be read as “at least one other embodiment”. Other definitions, explicit and implicit, may be included below.

[0035] FIG. 1 illustrates a communication environment 100 in which embodiments of the present disclosure can be implemented.

[0036] As shown in FIG. 1, the communication environment 100 may comprise a plurality of network devices 121, 122 and 123 and a UE 130. UE 130 may communicate with the plurality of network devices 121, 122 and 123. The cell 143 may be the serving cell of the UE 130, which may be considered as a reference cell of the UE 130, while the cells 141 and

142 may be considered as the neighboring cells. It should be understood that the reference cell may not be the serving cell of the UE 130. For example, the UE 130 is moving to the edge of the serving cell and has a better SNR of reference signal associated with other cell than that associated with the serving cell, in this case, the reference cell may be others than the serving cell.

[0037] A location server 110 may communicate with a UE 130 to obtain the positioning measurement report of the UE 130. In general, the location server 110 may receive the positioning measurement report from the UE 130 periodically. The location of the UE 130 may be determined by means of the Observed Time Difference Of Arrival (OTDOA) technology. As mentioned above, the OTDOA is a downlink positioning technique in which the target UE measures TOA (Time of Arrival) of the positioning reference signals (PRS) transmitted from the reference cell and neighbour cells, and reports the reference signal time differences (RSTDs), which are used to find location of the target device.

[0038] With reference to FIG.1, the time difference between the arrival time of the positioning reference signal from a reference cell 141 to the UE 130 and the arrival time of the positioning reference signal from a neighbouring cells 142 and 143 to the UE 130 may be used to determine the location of the UE 130 based on the predetermined algorithm. To support OTDOA, the higher layer signalling, i.e. the transfer of OTDOA assistance data and transfer of RSTD measurement, between the UE and location server, for example, an Evolved Serving Mobile Location Centre (E-SMLC) or a Service Positioning Protocol (SLP).

[0039] For the UE 130, it would be critical for providing not only the high accuracy positioning but also low measurement complexity for preserving battery lifetime. As the UE 130 may perform the positioning measurements (e.g. RSTD, SNR of TOA measurement etc.) based on assistance data provided by network and the resulting measurements based on positioning reference signals (PRS) or other reference signals are used to locate the UE 130. The existing positioning measurement approach would result in high complexity problem for the UE 130.

[0040] First, the location server may not have the SNR information of positioning measurements from the neighbouring cells to the target UE in advance, so the location server may need to configure enough number of neighbour cells, so as to improve the positioning performance of target UE. In LTE, up to 24 neighbouring cells belonging to the same or different frequency layers will be configured to the UE for positioning measurements so as to provide considerably accurate positioning performance.

[0041] Second, even if the location server may update the measurement list based on the positioning measurement report from the target UE, it may be difficult to ensure the positioning performance if the radio environment between the neighbouring cells and the target UE changes within the update period. Therefore, the location server may still keep enough number of neighbouring cells so as to ensure the positioning performance of target UE.

[0042] Although high positioning accuracy can be achieved to measurement a plurality of cells, for some certain situations, part of configured neighbouring cells may be enough to satisfy the requirements of positioning accuracy, such as E911 for positioning measurement. However, the positioning requirement from the location client is transparent for the target UE, and thus the UE has to measure all the configured neighbouring cells, which will lead to the unnecessary increase of the complexity burden and power consumption. To overcome the drawbacks, it is expected that the UE itself autonomously determine which cells it shall measure based on the assistance data configured by location server so as to provide not only the required positioning performance but also low measurement complexity for preserving battery lifetime.

[0043] Principle and implementations of the present disclosure will be described in detail below with reference to FIG. 2, which shows a process 200 according to example embodiments of the present disclosure. For the purpose of discussion, the process 200 will be described with reference to FIG. 1. The process 200 may involve an enhanced positioning mechanism based on OTDOA.

[0044] As shown in FIG. 2, the location client 201 may transmit 310 a location request for positioning a UE 130 to the location server 110. In some embodiments, the location request may include a positioning requirement associated with the UE 130. The positioning requirement may include, for example, positioning accuracy, a response time and service SNR of the location service. The positioning accuracy may depend on the type of the UE to be positioned. For example, it is not expected a very high positioning accuracy for an E911.

[0045] As an option, if there is no positioning requirement in the location request, default position accuracy can be specified by the location server 110 according to the certain regulation.

[0046] If the location server 110 receives the location request and determines the positioning requirement, the location server 110 determines 315 a positioning measurement configuration. The positioning measurement configuration may indicate the set of target cells for positioning the UE. In other word, the positioning measurement configuration may be considered a measurement rule for indicating that the cell to be measured by the UE 130 for positioning the UE 130 in a predetermined scenario.

[0047] In some embodiment, the location server 110 may require the UE 130 to preferentially measure a specific number of neighbouring cells in the measurement list with the minimum effective SNR requirement of TOA measurement related to PRS configuration.

[0048] In this case, the location server 110 may obtain the SNR threshold of the TOA and the PRS configuration for a reference cell of the UE 130. A SNR threshold may refer to, for example, a minimum effective Signal-Noise-Ratio (SNR) of the TOA for this PRS configuration. The PRS configuration for a reference cell of the UE 130, for example, may be included in a previous positioning measurement report from the UE 130, which may be transmitted 305, from the UE 130, to the location server 110 periodically.

[0049] In some embodiments, the SNR threshold may be preconfigured based on a predetermined PRS configuration. The location server 110 may determine a first mapping between the number of target cells and the SNR of the TOA measurement related to a predetermined PRS configuration of reference cell for a UE. As an option, the first mapping table may be obtained through experimental approach by using the reference positioning devices with known location.

[0050] Assume that the position scenario and PRS configuration for each cell are given, the location server can configure different cells to the reference positioning devices for OTDOA-based positioning measurement. As the location information of the reference positioning devices is known in advance, the location server could record the actual SNR of TOA measurement from each cell and achieve the positioning accuracy based on the report from the reference devices including e.g. RSTD and TOA from each cell and the corresponding SNR of the TOA measurement cells etc. In order to achieve desired positioning accuracy, the required SNR of TOA from each cell can be achieved through adjusting the transmit power of positioning gNB for a given number of cells for positioning measurement.

[0051] That is, since the PRS configuration for a reference cell of the UE 130 and a minimum effective Signal-Noise-Ratio (SNR) of the TOA for this PRS configuration are given, the location service 110 may determine the number of the target cells based on the first mapping. An example of the first mapping is shown in Table 1 as below, which may be used for the outdoor scenario; PRS configuration with 5 MHz bandwidth and 15KHz SCS and 1m desired position accuracy.

Table 1: An example of the first type of mapping table

SNR of TOA (dB)	Number of Required Cells
20	2
10	3
6	4
0	5
-3	6

[0052] If the location server 110 may determine the number of the target cells based on the first mapping, such as the Table 1, the location server 110 may determine the positioning measurement configuration based on the number of the target cells and the SNR threshold of the TOA.

[0053] In some embodiment, the positioning measurement rule may require the target UE to preferentially measure the specific neighbouring cells with minimum effective SNR requirement of TOA measurement related to the PRS configuration of the reference cell.

[0054] In this case, the location server 110 may obtain the PRS configuration for a reference cell of the UE 130 and a set of available cells of UE 130. The location server 110 may also obtain a SNR of TOA associated with a reference cell and a set of available cells of the terminal device.

[0055] Based on the PRS configuration for a reference cell and a set of available cells, and a SNR of TOA associated with a reference cell and a set of available cells, the location server 110 may determine a SNR threshold, for example, a minimum effective Signal-Noise-Ratio (SNR) of the TOA for this PRS configuration.

[0056] For the case that the PRS configuration of the reference cell is equal to the PRS configuration of the available cells, the location server 110 may select the target cells from the set of available cells based on the positioning requirement and the SNR threshold, which has a SNR not less than the minimum effective SNR and determine the positioning measurement configuration based on identities of the selected target cells.

[0057] For the case that the PRS configuration of the reference cell is different with the PRS configuration of the available cells, the location server 110 may determine a second mapping which indicates the relationship between the SNR of the TOA related to the the PRS configuration of the reference cell and the SNR of the TOA related to the PRS configuration of each cell in the set of the available cells.

[0058] The second mapping may be used to map the SNR of TOA measurement from one kind of PRS configuration to another kind of PRS configuration so as to achieve the same TOA accuracy. This type of mapping table is mainly used for the case of different PRS configuration per cell.

[0059] In some embodiments, the effective SNR of TOA measurement may be obtained through theoretical calculation approach. For example, assume that the PRS configuration for reference cell and neighbouring cell is considered for OTDOA positioning. The following estimation of effective SNR SNR_{nc-PRS} for the PRS of neighbouring cell can be got to reach the same Cramer-Rao lower bound (CRLB) of TOA measurement either using the PRS of neighbouring cell or the PRS of the reference cell. The second mapping may be represent as the following Equation:

$$\mathrm{SNR_{nc-PRS}} = \mathrm{SNR_{rc-PRS}} \cdot \frac{\mathrm{N_{symb}^{rc-PRS}}}{6\left(14\mathrm{M}-\mathrm{N_{symb}^{rc-PRS}}\right)} \quad (1)$$

where N_{symb} is the total number of OFDM symbols with the DL reference signals and M is the transmission duration of N_{symb}^{P-PRS} OFDM symbols in slot; SNR_{rc-PRS} is the SNR of TOA measurement for the PRS of reference cell.

[0060] In some embodiments, the effective SNR of TOA measurement can be obtained through experimental approach. For example, the location server can train the reference device to measure the TOA and the corresponding SNR for different PRS configuration in the actual positioning scenario. Based on the measurement information, a second mapping may be made to map the required SNR of TOA measurement for one kind of PRS configuration to another kind of PRS configuration with the same TOA accuracy.

[0061] In some embodiments, the location server 110 may determine the positioning measurement configuration based on the first mapping. In some embodiments, the location server 110 may determine the positioning measurement configuration based on the first and the second mapping. The first and second mapping herein may be considered as a kind of the positioning measurement configuration.

[0062] If the positioning measurement configuration is determined, the location server may transmit 320 the positioning measurement configuration to the UE 130.

[0063] In some embodiments, the positioning measurement configuration may be transmitted to the UE 130 along with the positioning assistance data through *ProvideAssistanceData* message base on the LTE Positioning Protocol (LPP) protocol.

[0064] Based on the positioning measurement configuration, the UE 130 performs 325 a positioning measurement of the cells associated with the positioning of the UE 130. The cells associated with the positioning may be indicated in the positioning measurement configuration or may be determined by the UE 130 based on the positioning measurement configuration.

[0065] As the SNR of TOA measurement from reference cell is the key for positioning accuracy, the UE 130 may perform TOA measurement from the reference cell, and fall back to the general positioning measurement, if the SNR of TOA measurement from the reference cell is lower than the required effective SNR indicated in the positioning measurement report. That is, the UE 130 may manage to measure other neighbouring cells in the measurement list so that the location server can improve the positioning accuracy using the measurement results from more neighbouring cells or/and update the assistance data to the UE 130 based on the report of measurement results.

[0066] In some embodiments, if the positioning measurement configuration indicates the specific number of the target cells, the UE 130 may select the corresponding number of the target cells from the measurement list based on the predetermined measurement order of the measurement list and perform the positioning measurement for each target cell in the set of target cells.

[0067] If the SNR of TOA for each target cell in the set of target cells is not less than a threshold TOA, the UE 130 may determine at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

[0068] In some embodiments, the measurement order can be the same as that provided by the location server in the measurement list.

[0069] In some embodiments, the UE 130 may determine the measurement order according to the SNR of TOA measurement based on previous results of TOA measurements. If there is not previous TOA measurement, the measurement order may be the same as that provided by the location server in the measurement list.

[0070] Specifically, the UE 130 may initialize the number of available neighbouring cells for positioning measurement with zero. If the PRS configuration for the measured neighbouring cell is different from that for the reference cell, the UE 130 may map the SNR of TOA measurement to an effective SNR of TOA measurement for the PRS configuration of reference cell. Otherwise, the effective SNR of TOA measurement is set to the actual SNR of TOA measurement from the neighbouring cell.

[0071] If the effective SNR of TOA measurement is large than the required effective SNR, the cell will be taken as one of the available cells. Otherwise, if the number of the available cells is large than the specific number of target cells provided by the network, it means that the UE 130 may stop the positioning measurement from other neighboring cells. Otherwise, the UE 130 may continue to measure other neighboring cells until the specific number is satisfied.

[0072] In some embodiments, if the positioning measurement configuration indicates the identities of the target cells, the UE 130 may select the set of target cells from a set of available cells of the UE 130 based on the identities of the target cells and perform the positioning measurement for each target cell in the set of target cells. If the SNR of TOA for each target cell in the set of target cells being not less than a SNR threshold of TOA, determining at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

[0073] Specifically, the UE 130 may measure the RSTD, the SNR of TOA measurement from the specific cells indicated in the positioning measurement configuration. If the PRS configuration for the measured cell is different from that for the reference cell, the UE 130 may map the SNR of TOA measurement to an effective SNR of TOA measurement for the PRS configuration of reference cell. Otherwise, the effective SNR of TOA measurement is set to the actual SNR of TOA measurement from the specific cell. If the effective SNR of TOA measurement from any specific cell is lower than the required effective SNR, the UE 130 may fall back to the general positioning measurement and to measure other neighbouring cells in the measurement list. Otherwise, the UE 130 may stop the positioning measurement from other neighbouring cells.

[0074] In some embodiments, if the positioning measurement configuration indicates a first mapping between the number of the target cells and a SNR threshold of TOA for a plurality of predetermined PRS configurations and a second mapping between a SNR of TOA related to a PRS configuration for a reference cell of the UE 130 and a SNR of TOA related to a PRS configuration for each of a set of target cells, the UE 130 may perform a positioning measurement for a set of available cells of the UE 130 and select, from the set of available cells, the set of target cells base on the first and second mapping and measurement results for each cell in the set of available cells.

[0075] Specifically, the UE 130 may measure the RSTD, the SNR of TOA measurement from the set of available cells in the measurement list with the given measurement order. The UE may initialize the number of measured available cells with zero. If the PRS configuration for the measured cell is different from that for the reference cell, the UE 130 may map the SNR of TOA measurement to an effective SNR of TOA measurement for the PRS configuration of reference cell. Otherwise, the effective SNR of TOA measurement is set to the actual SNR of TOA measurement from the available cells. After each measurement, the number of measured available cells increases one.

[0076] The UE 130 may check if any combination of TOA measurements from the measured available cells satisfies the positioning requirements by looking up the first mapping.

[0077] After finishing TOA measurement from one available cell, the UE 130 can look up the first mapping with the minimum effective SNR of TOA measurement from any combination of other measured available cells with the last measured available cell to estimate the number of required available cells for the desired positioning accuracy. If the number of required available cells is not larger than that of the measured available cells in the combination. The combination of measured available cells would be available.

[0078] If there is available combination of measured available cells which satisfies the positioning requirement, the UE 130 stops the positioning measurement from other available cells. Otherwise, the UE 130 may continue to measure other neighboring cells until the specific number of target cells is satisfied.

[0079] In some embodiments, the UE 130 may update the positioning measurement report based on the result of the positioning measurement and transmit 330 the updated location report to the location server 110.

[0080] In some embodiments, in order to reduce the signaling overhead for location information report, an embodiment is elaborated for the enhanced location report. For example, the UE 130 may only report the available measurements to the location server in the same order as provided by the location server and a bitmap table is designed to indicate the available neighboring cells in the measurement list which have been measured for positioning measurement (e.g. RSTD, SNR of ToA measurement).

[0081] In this way, a low-complexity positioning measurement for target UE based on configuration of positioning measurement rules provided by the location server is allowed, which may reduce the positioning measurement complexity and power consumption for the target UE and reduce the signalling overhead of UE for location report with enhanced positioning measurement report mechanism.

[0082] More details of the example embodiments in accordance with the present disclosure will be described with reference to FIGs. 3-4.

[0083] FIG. 3 shows a flowchart of an example method 300 for an enhanced positioning mechanism based on OTDOA according to some example embodiments of the present disclosure. The method 300 can be implemented at the location server 110 as shown in FIG. 1. For the purpose of discussion, the method 300 will be described with reference to FIG. 1.

[0084] At 310, if the location server 110 receives a location request for positioning a terminal device from a location client, the location server 110 obtains a positioning requirement associated with the terminal device from the location request.

[0085] In some embodiments, the location server 110 may obtain at least one of the following: distance accuracy, and response time for the location request.

[0086] At 320, the location server 110 determines a positioning measurement configuration at least partially based on the positioning requirement, the positioning measurement configuration indicating a set of target cells for positioning the terminal device.

[0087] In some embodiments, the location server 110 may obtain a Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) and a Positioning Reference Signal (PRS) configuration for a reference cell of the terminal device, the reference cell being different from the set of target cells; determine the number of the target cells based on the positioning requirement and the SNR threshold of the TOA related to the PRS configuration of the reference cell for the target device; and determine the positioning measurement configuration based on the number of the target cells and the SNR threshold of the TOA.

[0088] In some embodiments, the location server 110 may obtain, from the terminal device, a Signal-Noise-Ratio (SNR) of Time Of Arrival (TOA) associated with a reference cell and a set of available cells of the terminal device, the reference cell being different from the set of target cells; obtaining a Positioning Reference Signal (PRS) configuration for the reference cell and the set of available cells of the terminal device; determine a SNR threshold of the TOA related to the PRS configuration of the reference cell for the target device based on the SNR of the TOA associated with a reference cell and a set of available cells of the terminal device and the PRS configuration for the reference cell and the set of available cells of the terminal device; select the target cells from the set of available cells based on the positioning requirement and the SNR threshold of the TOA related to the PRS configuration of the reference cell for the target device; and determine the positioning measurement configuration based on identities of the target cells and the SNR threshold of the TOA.

[0089] In some embodiments, the location server 110 may determine a first mapping between the number of the target cells and a SNR threshold of Time Of Arrival (TOA) for a plurality of predetermined Positioning Reference Signal (PRS) configurations for the positioning accuracy and determine the positioning measurement configuration based on the first mapping.

[0090] In some embodiments, the location server 110 may determine a second mapping between a SNR of the TOA related to a Positioning Reference Signal (PRS) configuration for a reference cell of the terminal device and a SNR of the TOA related to a PRS configuration for each of a set of target cells and determine the positioning measurement configuration based on the second mapping.

[0091] At 330, the location server 110 transmits the positioning measurement configuration to the terminal device, to enable the terminal device to perform a positioning measurement based on the positioning measurement configuration.

[0092] In some embodiments, the location server 110 may further receive, from the terminal device, positioning measurement report being generating by the terminal device based on the positioning measurement configuration and determine a location of the terminal device based on the positioning measurement report. The location server 110 may provide the determined location of the terminal device to the location client.

[0093] FIG. 4 shows a flowchart of an example method 400 for an enhanced positioning mechanism based on OTDOA according to some example embodiments of the present disclosure. The method 400 can be implemented at the UE 130 as shown in FIG. 1. For the purpose of discussion, the method 400 will be described with reference to FIG. 1.

[0094] At 410, the UE 130 receives, at a terminal device, the positioning measurement configuration from a location server, the positioning measurement configuration being determined at least partially based on a positioning requirement associated with the terminal device and indicating a set of target cells for positioning the terminal device, the positioning requirement is obtained from a location request transmitted from a location client to the location server.

[0095] At 420, the UE 130 performs a positioning measurement based on the positioning measurement configuration.

[0096] In some embodiments, the UE 130 may obtain the number of the target cells and the Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) from the positioning measurement configuration and select the set of target cells from a set of available cells of the terminal device based on the number of the target cells and a predetermined measurement order of the set of available cells. The UE 130 may further perform the positioning measurement for each target cell in the set of target cells. If a SNR of Time Of Arrival (TOA) for each target cell in the set of target cells is not less than the SNR threshold of the TOA, the UE 130 may determine at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

[0097] In some embodiments, the UE 130 may obtain the identities of the target cells and the Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) from the positioning measurement configuration and select the set of target cells from a set of available cells of the terminal device based on the identities of the target cells. The UE 130 may further perform the positioning measurement for each target cell in the set of target cells. If a SNR of Time Of Arrival (TOA) for each target cell in the set of target cells is not less than the SNR threshold of the TOA, the UE 130 may determine at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

[0098] In some embodiments, the UE 130 may obtain from the positioning measurement configuration, a first mapping between the number of the target cells and a SNR threshold of Time Of Arrival (TOA) for a plurality of predetermined Positioning Reference Signal (PRS) configurations and a second mapping between a SNR of the TOA related to a Positioning Reference Signal (PRS) configuration for a reference cell of the terminal device and a SNR of the TOA related to a PRS configuration for each of a set of target cells and perform a positioning measurement for a set of available cells of the terminal device. The UE 130 may select, from the set of available cells, the set of target cells base on the first and second mapping and measurement results for each cell in the set of available cells and determines at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

[0099] At 430, the UE 130 determines a positioning measurement report based on a measurement result of the positioning measurement.

[00100] In some embodiments, the UE 130 may further generate a positioning measurement report of the terminal device, the positioning measurement report indicating at least one of the following: a Reference Signal Time Difference (RSTD) for a set of available cells of the terminal device, a Time Of Arrival (TOA) for a set of available cells of the terminal device, and a SNR of Time Of Arrival (TOA) associated with a set of available cells of the terminal device; and transmit the positioning measurement report to the location server.

[00101] In some embodiments, the UE 130 may obtain a positioning measurement report of the terminal device and generate, based on the positioning measurement and the result of the positioning measurement.

[00102] In some example embodiments, an apparatus capable of performing the method 300 (for example, implemented at the location server 110) may comprise means for performing the respective steps of the method 300. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

[00103] In some example embodiments, the apparatus comprises: means for in response to receiving, at a location server, a location request for positioning a terminal device from a location client, obtaining a positioning requirement associated with the terminal device from the location request; means for determining a positioning measurement configuration at least partially based on the positioning requirementt, the positioning measurement configuration indicating a set of target cells for positioning the terminal device; and means for transmitting the positioning measurement configuration to the terminal device, to enable the terminal device to perform a positioning measurement based on the positioning measurement configuration.

[00104] In some example embodiments, an apparatus capable of performing the method 400 (for example, implemented at the UE 130) may comprise means for performing the respective steps of the method 400. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

[00105] In some example embodiments, the apparatus comprises: means for receiving, at a terminal device, the positioning measurement configuration from a location server, the positioning measurement configuration being determined at least partially based on a positioning requirement associated with the terminal device and indicating a set of target cells for positioning the terminal device, the positioning requirement is obtained from a location request transmitted from a location client to the location server; means for performing a positioning measurement based on the positioning measurement configuration; and means for determining a positioning measurement report based on a result of the positioning measurement.

[00106] Fig. 5 is a simplified block diagram of a device 500 that is suitable for implementing embodiments of the present disclosure. The device 500 may be provided to implement the locations server 110 and the UE 130 as shown in FIG. 1. As shown, the device 500 includes one or more processors 510, one or more memories 520 coupled to the processor 510, and one or more transmitters and/or receivers (TX/RX) 540 coupled to the processor 510.

[00107] The TX/RX 540 is for bidirectional communications. The TX/RX 540 has at least one antenna to facilitate communication. The communication interface may represent any interface that is necessary for communication with other network elements.

[00108] The processor 510 may be of any type suitable to the local technical network and may include one or more of the following: general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 500 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[00109] The memory 520 may include one or more non-volatile memories and one or more volatile memories. Examples of the non-volatile memories include, but are not limited to, a Read Only Memory (ROM) 524, an electrically programmable read only memory (EPROM), a flash memory, a hard disk, a compact disc (CD), a digital video disk (DVD), and other magnetic storage and/or optical storage. Examples of the volatile memories include, but are not limited to, a random access memory (RAM) 522 and other volatile memories that will not last in the power-down duration.

[00110] A computer program 530 includes computer executable instructions that are executed by the associated processor 510. The program 530 may be stored in the ROM 524. The processor 510 may perform any suitable actions and processing by loading the program 530 into the RAM 522.

[00111] The embodiments of the present disclosure may be implemented by means of the program 530 so that the device 500 may perform any process of the disclosure as discussed with reference to Figs. 2 to 4. The embodiments of the present disclosure may also be implemented by hardware or by a combination of software and hardware.

[00112] In some embodiments, the program 530 may be tangibly contained in a computer readable medium which may be included in the device 500 (such as in the memory 520) or other storage devices that are accessible by the device 500. The device 500 may load the program 530 from the computer readable medium to the RAM 522 for execution. The computer readable medium may include any types of tangible non-volatile storage, such as ROM, EPROM, a flash memory, a hard disk, CD, DVD, and the like. Fig. 6 shows an example of the computer readable medium 600 in form of CD or DVD. The computer readable medium has the program 530 stored thereon.

[00113] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. For example, in some embodiments, various examples of the present disclosure (e.g., a method, apparatus or device) may be partly or fully implemented on the computer readable medium. While various aspects of embodiments of the present disclosure are illustrated and described as block diagrams, flowcharts, or using some other pictorial representation, it will be appreciated that the blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00114] The units included in the apparatuses and/or devices of the present disclosure may be implemented in various manners, including software, hardware, firmware, or any combination thereof. In one embodiment, one or more units may be implemented using software and/or firmware, for example, machine-executable instructions stored on the storage medium. In addition to or instead of machine-executable instructions, parts or all of the units in the apparatuses and/or devices may be implemented, at least in part, by one or more hardware logic components. For example, and without limitation, illustrative types of hardware logic components that can be used include Field-programmable Gate Arrays (FPGAs), Application-specific Integrated Circuits (ASICs), Application-specific Standard Products (ASSPs), System-on-a-chip systems (SOCs), Complex Programmable Logic Devices (CPLDs), and the like.

[00115] As examples, embodiments of the present disclosure may be described in the context of the computer-executable instructions, such as those included in program modules, being executed in a device on a target real or virtual processor. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data types. The functionality of the program modules may be combined or split between program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or distributed device. In a distributed device, program modules may be located in both local and remote storage media.

[00116] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. These program codes may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus, such that the program codes, when executed by the processor or controller, cause the functions/operations specified in the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on the machine and partly on a remote machine or entirely on the remote machine or server.

[00117] In the context of the present disclosure, a computer readable medium may be any tangible medium that may contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device. The computer readable medium may be a machine readable signal medium or a machine readable storage medium. The computer readable medium may include but not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the machine readable storage medium would include an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[00118] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain cases, multitasking and parallel processing may be advantageous. Likewise, while several specific embodiment details are contained in the above discussions, these should not be construed as limitations on the scope of the present disclosure, but rather as descriptions of features that may be specific to particular embodiments. Certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment may also be implemented in multiple embodiments separately or in any suitable sub-combination.

[00119] Although the present disclosure has been described in language specific to structural features and/or methodological acts, it would be appreciated that the present disclosure defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

WHAT IS CLAIMED IS:

1. A method, comprising:

in response to receiving, at a location server, a location request for positioning a terminal device from a location client, obtaining a positioning requirement associated with the terminal device from the location request;

determining a positioning measurement configuration at least partially based on the positioning requirement, the positioning measurement configuration indicating a set of target cells for positioning the terminal device; and

transmitting the positioning measurement configuration to the terminal device, to enable the terminal device to perform a positioning measurement based on the positioning measurement configuration.

2. The method of Claim 1, wherein obtaining the positioning requirement comprises obtaining at least one of the following:

positioning accuracy, and

response time for the location request.

3. The method of Claim 1, wherein determining the positioning measurement configuration comprises:

obtaining a Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) and a Positioning Reference Signal (PRS) configuration for a reference cell of the terminal device, the reference cell being different from the set of target cells;

determining the number of the target cells based on the positioning requirement and the SNR threshold of the TOA related to the PRS configuration of the reference cell for the target device; and

determining the positioning measurement configuration based on the number of the target cells and the SNR threshold of the TOA.

4. The method of Claim 1, wherein determining the positioning measurement configuration comprises:

obtaining, from the terminal device, a Signal-Noise-Ratio (SNR) of Time Of Arrival (TOA) associated with a reference cell and a set of available cells of the terminal device, the reference cell being different from the set of target cells;

obtaining a Positioning Reference Signal (PRS) configuration for the reference cell and the set of available cells of the terminal device;

determining a SNR threshold of the TOA related to the PRS configuration of the reference cell for the target device based on the SNR of TOA associated with the reference cell and a set of available cells of the terminal device and the PRS configuration for the reference cell and the set of available cells of the terminal device;

selecting the target cells from the set of available cells based on the positioning requirement and the SNR threshold of the TOA related to the PRS configuration of the reference cell for the target device; and

determining the positioning measurement configuration based on identities of the target cells and the SNR threshold of TOA.

5. The method of Claim 1, wherein determining the positioning measurement configuration comprises:

determining a first mapping between the number of the target cells and a Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) for a plurality of predetermined Positioning Reference Signal (PRS) configurations for the positioning requirement; and

determining the positioning measurement configuration based on the first mapping for the positioning requirement.

6. The method of Claim 1, wherein determining the positioning measurement configuration comprises:

determining a second mapping between a SNR of the TOA related to a Positioning Reference Signal (PRS) configuration for a reference cell of the terminal device and a SNR of the TOA related to a PRS configuration for each of a set of target cells; and

determining the positioning measurement configuration based on the second mapping.

7. The method of Claim 1, further comprising:

receiving, from the terminal device, a positioning measurement report being generating by the terminal device based on the positioning measurement configuration;

determining a location of the terminal device based on the positioning measurement report; and providing the determined location of the terminal device to the location client.

8. A method, comprising:

receiving, at a terminal device, a positioning measurement configuration from a location server, the positioning measurement configuration being determined at least partially based on a positioning requirement associated with the terminal device and indicating a set of target cells for positioning the terminal device, the positioning requirement is obtained from a location request transmitted from a location client to the location server;

performing a positioning measurement based on the positioning measurement configuration; and

determining a positioning measurement report based on a measurement result of the positioning measurement.

9. The method of Claim 8, wherein performing a positioning measurement comprises:

obtaining the number of the target cells and a Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) from the positioning measurement configuration;

selecting a set of target cells from a set of available cells of the terminal device based on the number of the target cells and a predetermined measurement order of the set of available cells;

performing the positioning measurement for each target cell in the set of target cells; and

in response to a SNR of TOA for each target cell in the set of target cells being not less than the SNR threshold of TOA, determining at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

10. The method of Claim 8, wherein performing the positioning measurement comprises:

obtaining the identities of the target cells and the Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) from the positioning measurement configuration;

selecting the set of target cells from a set of available cells of the terminal device based on the identities of the target cells;

performing the positioning measurement for each target cell in the set of target cells; and

in response to a SNR of TOA for each target cell in the set of target cells being not less than the SNR threshold of TOA, determining at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

11. The method of Claim 8, wherein performing the positioning measurement comprises:

obtaining, from the positioning measurement configuration, a first mapping between the number of the target cells and a Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) for a plurality of predetermined Positioning Reference Signal (PRS) configurations and a second mapping between a SNR of the TOA related to a PRS configuration for a reference cell of the terminal device and a SNR of the TOA related to a PRS configuration for each of a set of target cells;

performing a positioning measurement for a set of available cells of the terminal device;

selecting, from the set of available cells, the set of target cells based on the first and second mapping and the measurement results for each cell in the set of available cells; and

determining at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

12. The method of Claim 8, further comprising:

generating the positioning measurement report of the terminal device, the positioning measurement report indicating at least one of the following:

a Reference Signal Time Difference (RSTD) for a set of available cells of the terminal device, and

a Time Of Arrival (TOA) for a set of available cells of the terminal device, and

a SNR of TOA associated with a set of available cells of the terminal device; and

transmitting the location measurement report to the location server.

13. A device, comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the device at least to:

in response to receiving, at a location server, a location request for positioning a terminal device from a location client, obtain a positioning requirement associated with the terminal device from the location request;

determine a positioning measurement configuration at least partially based on the positioning requirement, the positioning measurement configuration indicating a set of target cells for positioning the terminal device; and

transmit the positioning measurement configuration to the terminal device, to enable the terminal device to perform a positioning measurement based on the positioning measurement configuration.

14. The device of Claim 13, wherein the device is caused to obtain the positioning requirement by obtaining at least one of the following:

positioning accuracy, and

response time for the location request.

15 The device of Claim 13, wherein the device is caused to determine the positioning measurement configuration by:

obtaining a Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) and a Positioning Reference Signal (PRS) configuration for a reference cell of the terminal device, the reference cell being different from the set of target cells;

determining the number of the target cells based on the positioning requirement and the SNR threshold of the TOA related to the PRS configuration of the reference cell for the target device; and

determining the positioning measurement configuration based on the number of the target cells and the SNR threshold of TOA.

16. The device of Claim 13, wherein the device is caused to determine the positioning measurement configuration by:

obtaining, from the terminal device, a Signal-Noise-Ratio (SNR) of Time Of

Arrival (TOA) associated with a reference cell and a set of available cells of the terminal device;

obtaining a Positioning Reference Signal (PRS) configuration for the reference cell and the set of available cells of the terminal device, the reference cell being different from the set of target cells;

determining a SNR threshold of the TOA related to the PRS configuration of the reference cell for the target device based on the SNR of the TOA associated with a reference cell and a set of available cells of the terminal device and the PRS configuration for the reference cell and the set of available cells of the terminal device;

selecting the target cells from the set of available cells based on the positioning requirement and the SNR threshold of the TOA related to the PRS configuration of the reference cell for the target device; and

determining the positioning measurement configuration based on identities of the target cells and the SNR threshold of TOA.

17. The device of Claim 14, wherein the device is caused to determine the positioning measurement configuration by:

determining a first mapping between the number of the target cells and a Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) for a plurality of predetermined Positioning Reference Signal (PRS) configurations for the positioning requirement; and

determining the positioning measurement configuration based on the first mapping for the positioning requirement.

18. The device of Claim 13, wherein the device is caused to determine the positioning measurement configuration by:

determining a second mapping between a SNR of the TOA related to a Positioning Reference Signal (PRS) configuration for a reference cell of the terminal device and a SNR of the TOA related to a PRS configuration for each of a set of target cells; and

determining the positioning measurement configuration based on the second mapping.

19. The device of Claim 13, wherein the device is further caused to:

receive, from the terminal device, a positioning measurement report being generating by the terminal device based on the positioning measurement configuration;

determine a location of the terminal device based on the positioning measurement report ; and

provide the determined location of the terminal device to the location client.

20. A device, comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the device at least to:

receiving, at a terminal device, the positioning measurement configuration from a location server, the positioning measurement configuration being determined at least partially based on a positioning requirement associated with the terminal device and indicating a set of target cells for positioning the terminal device, the positioning requirement is obtained from a location request transmitted from a location client to the location server;

performing a positioning measurement based on the positioning measurement configuration; and

determine a positioning measurement report based on a measurement result of the positioning measurement.

21. The device of Claim 20 wherein the device is caused to perform a positioning measurement by:

obtaining the number of the target cells and the Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) from the positioning measurement configuration;

selecting the set of target cells from a set of available cells of the terminal device based on the number of the target cells and a predetermined measurement order of the set of available cells;

performing the positioning measurement for each target cell in the set of target cells; and

in response to a SNR of (TOA) for each target cell in the set of target cells being not less than the SNR threshold of TOA, determining at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

22. The device of Claim 20, wherein the device is caused to perform a positioning measurement by:

obtaining the identities of the target cells and the Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) from the positioning measurement configuration;

selecting the set of target cells from a set of available cells of the terminal device based on the identities of the target cells;

performing the positioning measurement for each target cell in the set of target cells; and

in response to a SNR of TOA for each target cell in the set of target cells being not less than the SNR threshold of TOA, determining at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

23. The device of Claim 20, wherein the device is caused to perform a positioning measurement by:

obtaining, from the positioning measurement configuration, a first mapping between the number of the target cells and a Signal-Noise-Ratio (SNR) threshold of Time Of Arrival (TOA) for a plurality of predetermined Positioning Reference Signal (PRS) configurations and a second mapping between a SNR of the TOA related to a PRS configuration for a reference cell of the terminal device and a SNR of the TOA related to a PRS configuration for each of a set of target cells;

performing a positioning measurement for a set of available cells of the terminal device;

selecting, from the set of available cells, the set of target cells based on the first and second mapping and the measurement results for each cell in the set of available cells; and

determining at least one of a TOA, the SNR of the TOA and a Reference Signal Time Differences (RSTD) for each target cell in the set of target cells as the measurement result.

24. The device of Claim 20, wherein the device is further caused to:

generate a positioning measurement report of the terminal device, the positioning measurement report indicating at least one of the following:

a Reference Signal Time Difference (RSTD) for a set of available cells of the terminal device, and

a Time Of Arrival (TOA) for a set of available cells of the terminal device, and

a SNR of TOA associated with a set of available cells of the terminal device; and

transmit the positioning measurement report to the location server.

25. An apparatus, comprising:

means for in response to receiving, at a location server, a location request for positioning a terminal device from a location client, obtaining a positioning requirement associated with the terminal device from the location request;

means for determining a positioning measurement configuration at least partially based on the positioning requirement, the positioning measurement configuration indicating a set of target cells for positioning the terminal device; and

means for transmitting the positioning measurement configuration to the terminal device, to enable the terminal device to perform a positioning measurement based on the positioning measurement configuration.

26. An apparatus, comprising:

means for receiving, at a terminal device, the positioning measurement configuration from a location server, the positioning measurement configuration being determined at least partially based on a positioning requirement associated with the terminal device and indicating a set of target cells for positioning the terminal device, the positioning requirement is obtained from a location request transmitted from a location client to the location server;

means for performing a positioning measurement based on the positioning measurement configuration; and

means for determining a positioning measurement report based on a measurement result of the positioning measurement.

27. A non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method of any of claims 1-7.

28. A non-transitory computer readable medium comprising program instructions

for causing an apparatus to perform at least the method of any of claims 8-12.

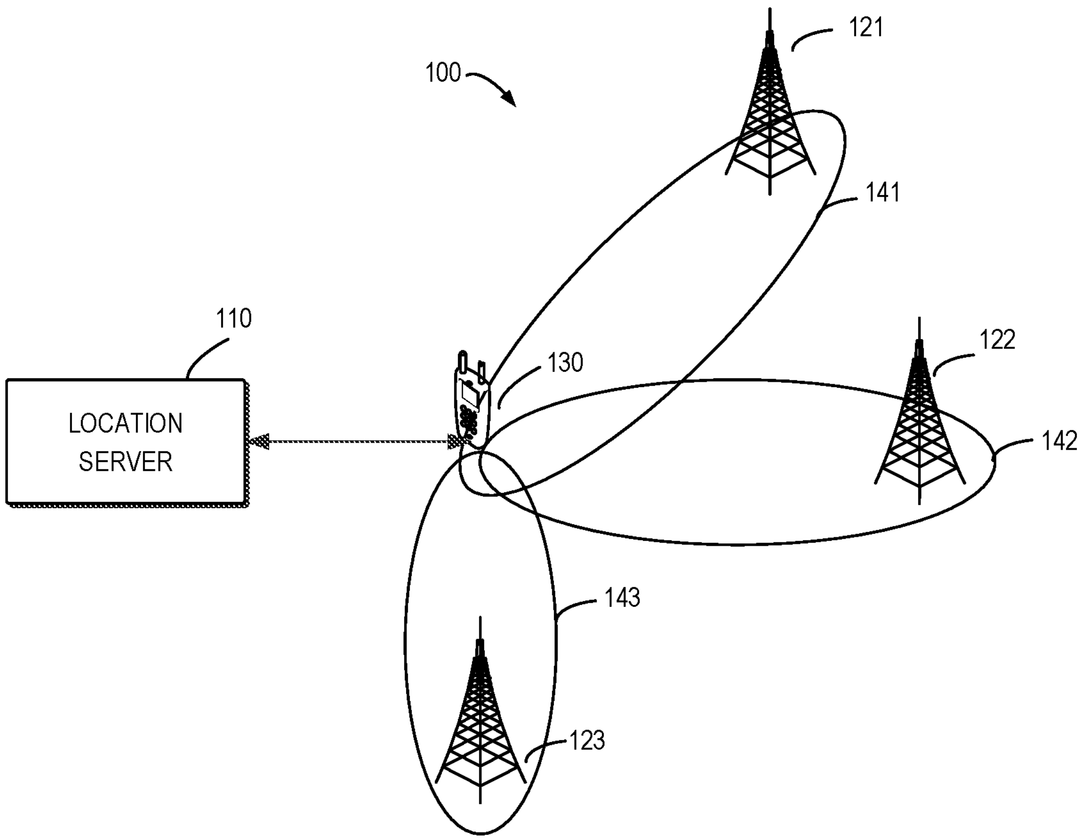
100
121
141
110
LOCATION
SERVER
130
122
142
143
123

FIG. 1

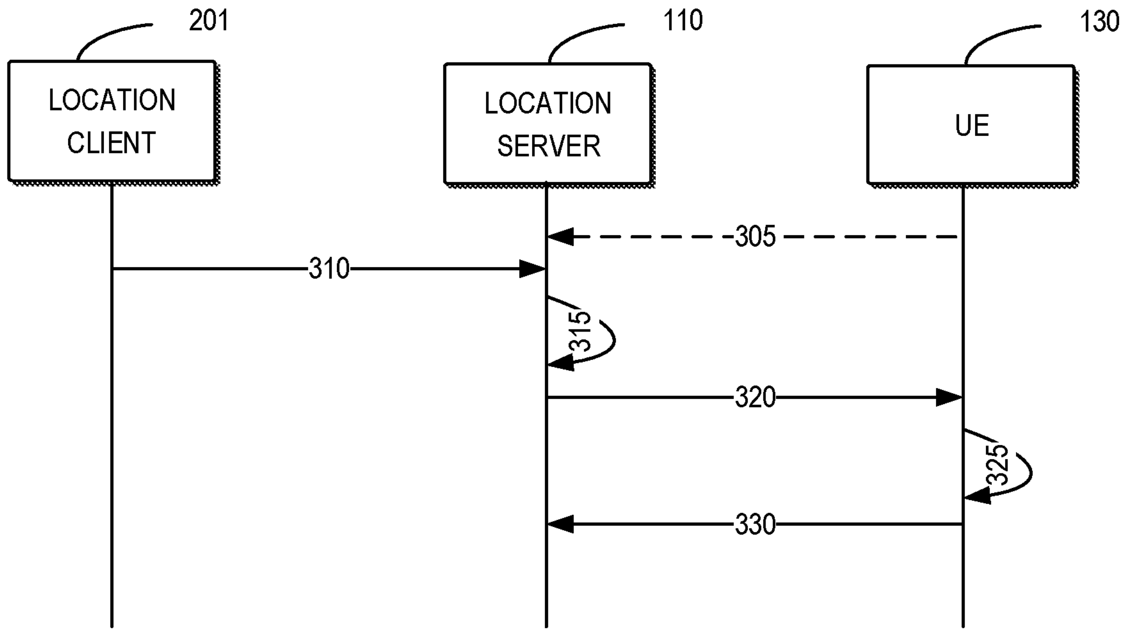
201
110
130
LOCATION
CLIENT
LOCATION
SERVER
UE
305
310
315
320
325
330

FIG. 2

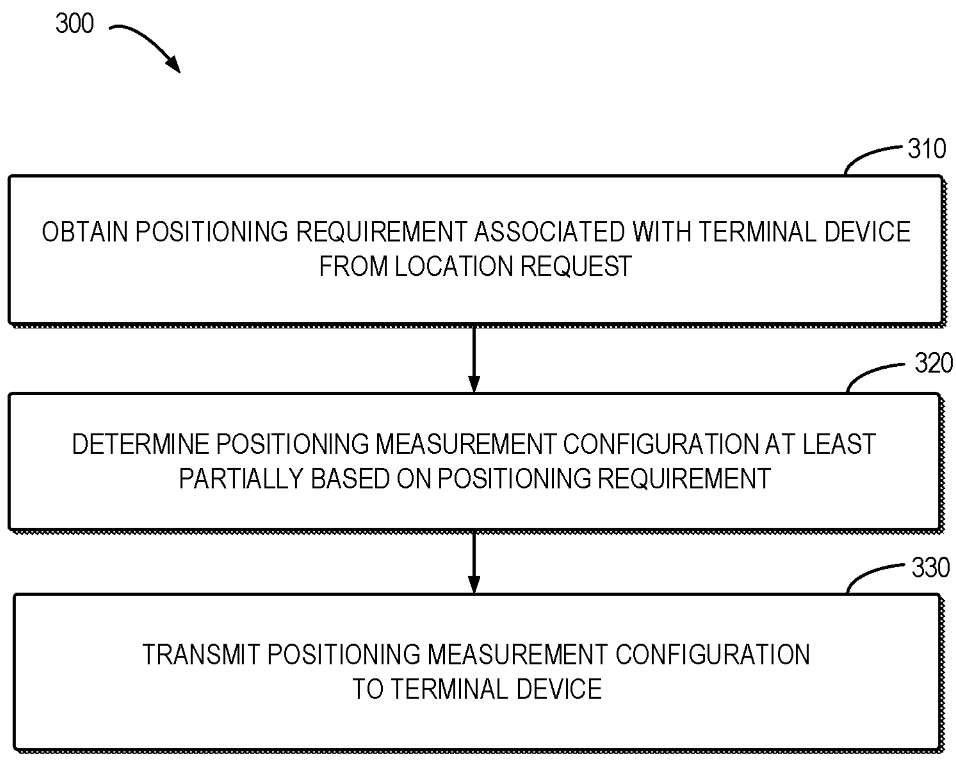
300
310
OBTAIN POSITIONING REQUIREMENT ASSOCIATED WITH TERMINAL DEVICE FROM LOCATION REQUEST
320
DETERMINE POSITIONING MEASUREMENT CONFIGURATION AT LEAST PARTIALLY BASED ON POSITIONING REQUIREMENT
330
TRANSMIT POSITIONING MEASUREMENT CONFIGURATION TO TERMINAL DEVICE

FIG. 3

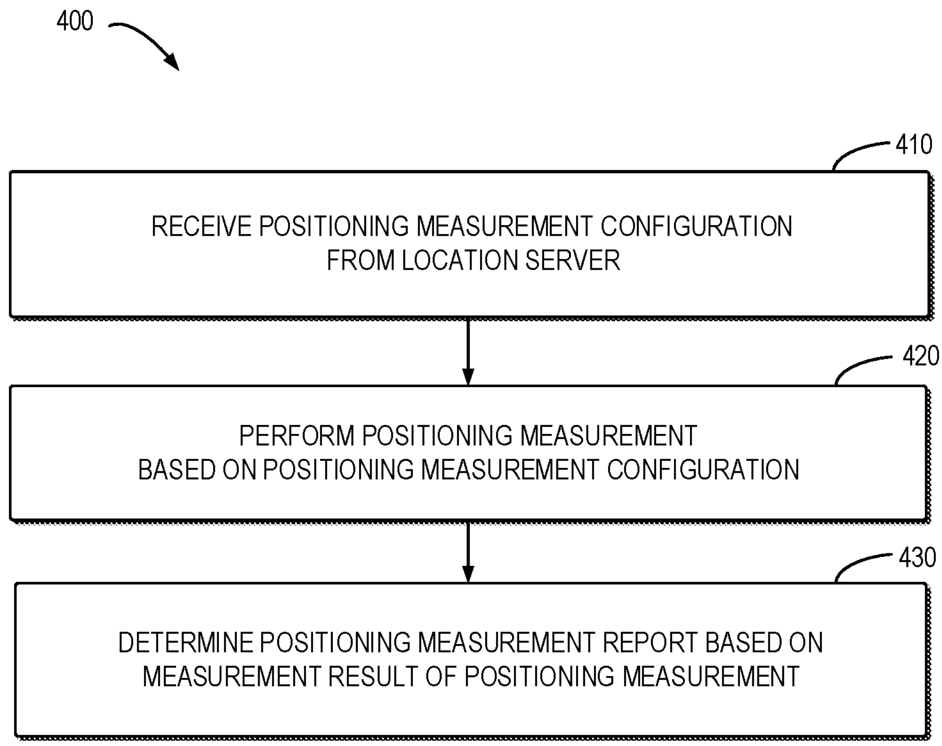
400
410
RECEIVE POSITIONING MEASUREMENT CONFIGURATION FROM LOCATION SERVER
420
PERFORM POSITIONING MEASUREMENT BASED ON POSITIONING MEASUREMENT CONFIGURATION
430
DETERMINE POSITIONING MEASUREMENT REPORT BASED ON MEASUREMENT RESULT OF POSITIONING MEASUREMENT

FIG. 4

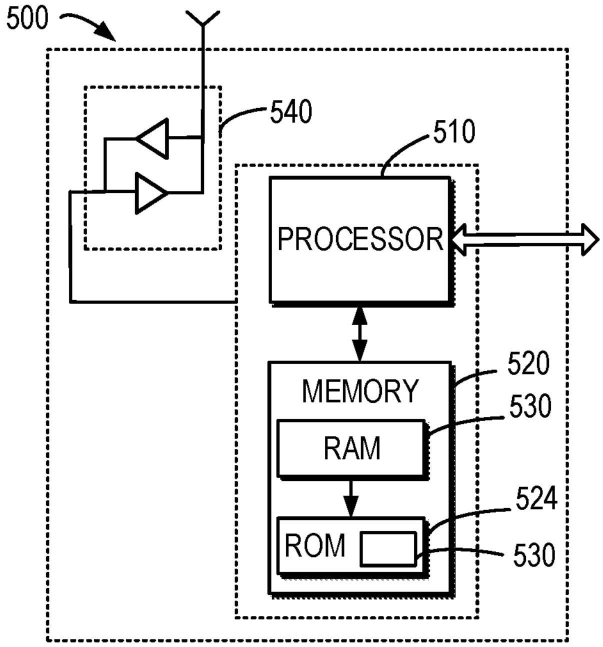

FIG. 5

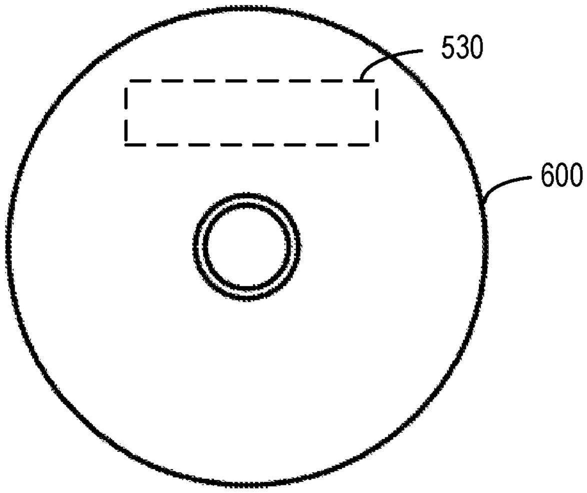

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/074795

A. CLASSIFICATION OF SUBJECT MATTER

H04W 64/00(2009.01)i； G01S 5/02(2010.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W, G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS,CNKI,CNTXT,VEN,EPTXT,USTXT,WOTXT: positioning, location, request,measurement, configuration, target, set, cell, base station, enb, gnb

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2017219283 A1 (HUAWEI TECH. CO., LTD.) 28 December 2017 (2017-12-28) description, page 8, line 1 to page 27, line 15	1-28
A	CN 106572529 A (SAMSUNG ELECTRONICS CO., LTD.) 19 April 2017 (2017-04-19) the whole document	1-28
A	WO 2018085078 A1 (INTEL IP CORP) 11 May 2018 (2018-05-11) the whole document	1-28
A	CN 102724699 A (CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY) 10 October 2012 (2012-10-10) the whole document	1-28
A	CN 107046677 A (LG ELECTRONICS INC.) 15 August 2017 (2017-08-15) the whole document	1-28

☐ Further documents are listed in the continuation of Box C.　　☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 July 2019	**20 August 2019**

Name and mailing address of the ISA/CN	Authorized officer
National Intellectual Property Administration, PRC **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**WANG,Wei**
Facsimile No. **(86-10)62019451**	Telephone No. **86-10-62089398**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/074795

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2017219283	A1	28 December 2017	CN	109314944	A	05 February 2019
				EP	3461190	A4	10 April 2019
				EP	3461190	A1	27 March 2019
				US	2019132816	A1	02 May 2019
CN	106572529	A	19 April 2017	KR	20170042174	A	18 April 2017
				US	9720070	B2	01 August 2017
				US	2017102447	A1	13 April 2017
WO	2018085078	A1	11 May 2018	None			
CN	102724699	A	10 October 2012	CN	102186191	A	14 September 2011
CN	107046677	A	15 August 2017	CN	103329604	A	25 September 2013
				JP	2016001188	A	07 January 2016
				US	2015365836	A1	17 December 2015
				JP	6185520	B2	23 August 2017
				US	2013260793	A1	03 October 2013
				KR	20130115321	A	21 October 2013
				EP	2652995	B1	02 August 2017
				JP	5796085	B2	21 October 2015
				WO	2012081861	A3	04 October 2012
				US	9961680	B2	01 May 2018
				WO	2012081861	A2	21 June 2012
				US	2016286552	A1	29 September 2016
				US	9374728	B2	21 June 2016
				EP	2652995	A4	31 August 2016
				US	9084127	B2	14 July 2015
				KR	101527041	B1	09 June 2015
				EP	2652995	A2	23 October 2013
				JP	2014504369	A	20 February 2014
				CN	103329604	B	05 April 2017